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GB 1582818 A EP 0608780 A2 EP 0567970 A1
US 5644014 A

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(54) Abstract Title
Coated baking foil

(57) A baking foil comprises a sheet of aluminium coated with a release layer of a fluorosilane compound to function as a baking product release agent. The release layer is bonded to the naturally formed oxide layer on the surface of the sheet, and is formed by curing on the sheet a bifunctional silane compound having at least one functional group capable of bonding to the oxide layer and at least one fluoroalkyl chain capable of forming, after curing, a low energy surface on the foil. The release agent is non-toxic, relatively inert and thermally stable up to about 260°C. The functional group may be a hydrolysable group and the fluoroalkyl chain may be a perfluoroalkyl chain. Although the fluorosilane compound when applied can be dissolved, dispersed or otherwise carried in an organic solvent, preferably the compound is dissolved or dispersed in water.

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BAKING FOIL

The present invention relates to a baking foil suitable for supporting or enveloping a food product during the cooking thereof in an oven.

Since a baking foil should not interact adversely with the food product during cooking and should itself be thermally stable up to the highest oven temperatures likely to be reached in a domestic or commercial oven, it is common for a baking foil to be made of a sheet of substantially pure aluminium. Aluminium does, however, have a tendency to stick to certain food products during cooking, and it is therefore desirable for the surface of the aluminium sheet to be treated in such a way as to reduce its adhesion to food products. One known method is to arrange for the surface of the aluminium sheet in contact with the food product to be highly polished so as to reduce surface defects around which adhesion with a food product could be increased. A second alternative is to coat the aluminium sheet with a lacquer, but such lacquers tend to degrade thermally during the cooking process, and also the production of lacquer-coated aluminium sheet can give rise to environmental contamination problems because of the solvents frequently used in the lacquer coating process.

For aluminium cookware a frequently used non-stick coating material is PTFE, but not only is the coating material itself expensive for a short lived product such as a baking foil, but also in order to obtain satisfactory adhesion between aluminium and PTFE a primer layer generally has to be provided at increased cost of both materials and production.

For such a PTFE layer it is known to use as a primer layer an organofunctional silane wherein one of the functional groups is hydrolysable, since it is known that such silanes adhere strongly to the oxide layer invariably present on the surface of an aluminium sheet. Such silanes possess other functional groups which bond with the PTFE. Examples of such silanes are given in EP-A-0624404, which describes the formation of a surface-treated substrate having at least two treated surface layers thereon.

It is known to use certain organofunctional silanes as single layer surface treatment coatings without additional layer thereon, but generally only for the waterproofing of paper, textiles, yarns and the like. Heretofore it has not been known to use an organofunctional silane as a sole coating layer on an aluminium sheet.

In accordance with the present invention there is provided a baking foil comprising a sheet of substantially pure aluminium having coated thereon a layer of a fluorosilane compound adapted to function as a baking product release agent, wherein the release layer is bonded to the naturally formed oxide layer on the surface of the aluminium sheet, wherein the release agent is formed by curing on the sheet a bifunctional silane compound having at least one functional group capable of bonding to the said oxide layer and at least one fluoroalkyl chain capable of forming after curing a low

energy surface on the foil, and wherein the release agent is non-toxic, relative inert and thermally stable up to about 260°C.

It is preferred that the fluorosilane compound be selected such that upon curing any volatile compounds which are evolved are essentially non-toxic.

Preferably the at least one functional group is a hydrolysable group, and more preferably the silane comprises three hydrolysable groups in order to ensure good adhesion to the oxide layer on the aluminium surface. Desirably each hydrolysable group is an ethoxy group.

As will be appreciated by those skilled in the art the at least one functional group of the silane which does not bond to the oxide layer of the aluminium sheet can in theory comprise a wide range of substituent groups. The choice of this other functional group - preferably there is only one - will be governed principally by the requirement that the resulting release layer must be non-toxic, must not thermally degrade during the cooking process, and must be chemically inert with the respect of all possible food products under cooking conditions. The substituent should also provide a low energy surface on as large an area of the foil surface as possible for as small an amount of silane as possible. Although normal alkyl groups such as octyl are possible, it has been found that such groups can interact adversely with certain food products, and accordingly for the present invention a fluoroalkyl substituent is used.

It has been found generally sufficient for one fluoroalkyl substituent to be present in the form of a branched or preferably normal chain. The fluoroalkyl chain is preferably a perfluoroalkyl chain, and desirably provides a release layer on the aluminium foil which is thermally stable up to about 230°C. For conventional aluminium foil the most preferred silane compound is 1H,1H, 2H, 2H-perfluorooctyl triethoxysilane, but another fluorosilane may be more desirable for an aluminium foil of a different alloy composition.

By using such a silane, a release layer of less than 500 nanometres or 0.5μm thick can be achieved, which means that a small amount of release agent can cover a very large area of foil. The currently preferred commercial product is available from ABCR-Gelest (UK) Limited under the trade mark DYNASYLAN F8261.

The baking foil of the present invention can be coated and produced in the form of an elongate strip capable of being coiled into a roll with a preferred thickness of between 6 and 20μm.

The present invention also provides a method of producing a baking foil of the type described above comprising:-

(i) optionally cleaning by means of a corona discharge the surface of the aluminium sheet to be coated,

(ii) applying a layer of the said fluorosilane compound onto the surface of the sheet, and

(iii) curing the said compound so as to bond the cured compound to the naturally formed oxide layer on the surface of the sheet.

Although the fluorosilane compound can be dissolved, dispersed or otherwise carried in an organic solvent such as ethanol, either pure or diluted with water, it is preferred that the compound be dissolved or dispersed in water, having therein a small amount of a wetting agent, such as a known silane-based wetting agent or ethanol. The use of a solvent such as ethanol as a wetting agent may also help to remove any unwanted organic contamination from the surface of the sheet before coating.

When such an aqueous dispersion of the fluorosilane is prepared, it starts to hydrolyse quite slowly and is usable from less than 30 minutes to 24 hours or even longer, indeed between five minutes and ten days, before the hydrolysis process goes too far and the adhesion of the fluorosilane compound to the aluminium foil is adversely affected. To assist the hydrolysis of the fluorosilane on the aluminium foil the pH of the aqueous solution is preferably controlled to a pH between slightly acid and slightly alkaline depending on the particular silane used. For the above-mentioned most prefered silane the pH is adjusted to between 4.0 and 4.5 with a suitable acid such as acetic acid. If for a particular type of coating layer some etching of the aluminium's oxide layer is required then the pH of the solution can be adjusted to between 7.5 and 8.5 with a

suitable alkali such as caustic soda. The pH range could be, however, adjusted between 1 and 10.

Desirably the aqueous medium of the solution comprises about 95% by weight of water, preferably purified by reverse osmosis, and about 5% by weight of ethanol, and the fluorosilane compound is present at a dilution level of between 0.01 and 5% by weight of the solution to be applied, more preferably between 0.05 and 2% and even more prferably between 0.2 and 0.5%. A dilution level for the silane of about 1% by weight has been found in practice to be satisfactory.

Although a variety of known coating methods including reverse roller coating can be used to apply the fluorosilane compound onto the foil, it is preferred that the aluminium sheet be immersed in a solution or dispersion of the compound so as uniformly and thoroughly to wet the surface of the sheet to be coated. The wetted sheet is then dried in order to cure the compound. Forced drying using infra red radiation or blown hot air at temperatures up to 400°C can be used, but preferably the drying is carried out using simple air drying at less than about 110°C, more preferably less than about 60°C.

With a simple immersion process the method of the present invention can be performed substantially continuously with the sheet to be coated in the form of a coiled roll, with running speeds for the sheet of from 30 to 1000m per minute, preferably from 150 to 300m per minute.

Although the surface of the aluminium sheet which is not intended to be presented to the food product after coating with the release layer need not be itself coated, the immersion method of the present invention will result in both surfaces of the sheet being coated. This can be of advantage during the coiling, storage and uncoiling of the sheet as there is then reduced friction and adhesion between neighbouring coils. For some applications it may be preferable to laminate this remote surface with a polyester layer or the like prior to coating with the fluorosilane in order to improve the tear strength of the resulting aluminium foil.

By using the described bi-functional fluorosilane compound on an aluminium baking foil a low cost sheet with good release properties can be obtained without the need for any additional coating.

CLAIMS:

1. A baking foil comprising a sheet of substantially pure aluminium having coated thereon a layer of a fluorosilane compound adapted to function as a baking product release agent, wherein the release layer is bonded to the naturally formed oxide layer on the surface of the aluminium sheet, wherein the release agent is formed by curing on the sheet a bifunctional silane compound having at least one functional group capable of bonding to the said oxide layer and at least one fluoroalkyl chain capable of forming after curing a low energy surface on the foil, and wherein the release agent is non-toxic, relatively inert and thermally stable up to about 260°C.

2. A foil as claimed in claim 1 wherein the fluorosilane compound is selected such that upon curing any volatile compounds which are evolved are essentially non-toxic.

3. A foil as claimed in claim 1 or claim 2 wherein the said at least one functional group is a hydrolysable group.

4. A foil as claimed in claim 3 wherein the fluorosilane compound comprises three hydrolysable groups.

5. A foil as claimed in any one of the preceding claims wherein the fluoroalkyl chain is a perfluoroalkyl chain.

6. A foil as claimed in any one of the preceding claims wherein the release agent is thermally stable up to about 230°C.

7. A foil as claimed in claim 6 wherein the fluorosilane compound is 1H,1H, 2H, 2H-perfluorooctyl triethoxysilane.

8. A foil as claimed in any one of the preceding claims wherein the release layer is less than about 500 nanometres.

9. A foil as claimed in any one of preceding claims in the form of an elongate strip capable of being coiled into a roll.

10. A foil as claimed in claim 9 having a thickness of between 6 and 20μm.

11. A foil as claimed in claim 1 substantially as hereinbefore described.

12. A method of producing a baking foil as claimed in any one of the preceding claims comprising -

(i) optionally cleaning by means of a corona discharge the surface of the aluminium sheet to be coated,

(ii) applying a layer of the said fluorosilane compound onto the surface of the sheet, and

(iii) curing the said compound so as to bond the cured compound to the naturally formed oxide layer on the surface of the sheet.

13. A method as claimed in claim 12 wherein the fluorosilane compound is applied in the form of a dilute aqueous solution or dispersion.

14. A method as claimed in claim 13 wherein the pH of the aqueous solution is adjusted with acetic acid to between 4.0 and 4.5.

15. A method as claimed in claim 13 or claim 14 wherein the aqueous medium of the solution or dispersion comprises about 95% by weight of water, preferably purified by reverse osmosis, and about 5% by weight of ethanol, and wherein the fluorosilane compound is present at a dilution level of between 0.01 and 5% by weight of the solution or dispersion to be applied.

16. A method as claimed in claim 15 wherein the silane dilution level is about 1% by weight.

17. A method is claimed in any one of claims 12 to 16 comprising immersing the sheet in a solution or dispersion of the fluorosilane compound so as to wet the surface of the sheet to be coated and then drying the wetted sheet to cure the compound.

18. A method as claimed in claim 17 wherein the drying is air drying and is carried out at less than about 110°C.

19. A method as claimed in claim 18 wherein the air drying is carried out at less than about 60°C.

20. A method is claimed in any one of the preceding claims when performed substantially continuously in which the sheet to be coated is in the form of a coiled roll and the steps of the method are carried out at a running speed for the sheet of from 30 to 1000 m per minute.

21. A method as claimed in claim 20 wherein the running speed for the sheet is from 150 to 300m per minute.

22. A method as claimed in claim 12 substantially as hereinbefore described.

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Application No: GB 0013524.4 **Examiner:** R.J.MIRAMS
Claims searched: 1 to 22 **Date of search:** 23 November 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): B2E

Int Cl (Ed.7): A21B 3/15. A47J 36/02. B05D 7/14. B32B 15/08. B65D 65/42. C09D 183/08.

Other: ONLINE: WPI, EPODOC, JAPIO.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 1582818A	(IBM)	
A	EP 0608780A2	(DOW CORNING)	
A	EP 0567970A1	(DOW CORNING)	
A	US 5644014A	(SCHMIDT)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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